DISCUSSION AND CORRESPONDENCE

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

To the Editor of Science: Your article "Doctorates conferred by American Universities" (Science, No. 973) is a valuable statement of facts from which you have wisely refrained from drawing conclusions. I fear that many of your readers will take it almost as a matter of course that those institutions which confer the largest number of doctor's degrees are the ones which are doing most for the highest education and for the progress of scholarship in America. This inference is not merely erroneous but is distinctly harmful. It is true that those institutions which succeed in collecting the largest number of students with the capacity and preparation necessary for doing work to some slight extent original, and which have teachers able and willing to inspire their students with the desire to do productive work are contributing most to the scientific advancement of the country. It is also true that *other things being equal* such institutions will produce each year the largest numbers of doctors. There is, however, another element of fundamental importance which is too often left out of account. The level of attainment and capacity of our doctors is, on the average, below that of German doctors, and these latter stand far below the doctors of several other European nations, such as France or the Scandinavian countries. In these latter countries the holder of the doctor's degree may, to use your phrase, be said to be "officially certified as competent to undertake advanced teaching and research work." In Germany and in this country such a statement must be taken in a decidedly Pickwickian sense, most doctors there being quite unable to stand alone scientifically. This is of less consequence in Germany, where the keen competition of the best doctors for academic promotion gives a sufficient incentive to further development beyond the usually rather low level of the doctor's degree. In this country such incentives are to a large extent lacking, and it is the duty of the strongest universities to raise the level of the doctor's degree distinctly above the standard set in Germany. Some of our strongest institutions are aware of this fact and try, even if as yet only in an uncertain and halting manner, to perform this duty in spite of the competition of the weaker institutions, some of which are glad to give the degree to men of doubtful qualifications. To expect uniformity of standard here would be Utopian; but it is important that in judging the relative success of different universities the quality of the output be given at least as much weight as the quantity. I, for one, hope the time is still very far distant when as large a proportion of our population take the doctor's degree as is the case in Germany.

Maxime Bôcher
Harvard University

AIR IN THE DEPTHS OF THE OCEAN

Several months ago three communications relating to the manner in which the water in the depths of the ocean is aerated, appeared in Science[1] and a recent review[2] of them has served to call attention to this subject again. Before the question is finally dismissed it may be worth while to point out that the single factor, namely, diffusion, suggested in these articles as the sole agent involved, plays only a negligible rôle in the process of aeration. The atmospheric gases diffuse very slowly through water, the coefficient of nitrogen being 1.73, of oxygen 1.62, and of carbon dioxide 1.38. The rapidity with which oxygen is transferred is well illustrated by Hüfner's[3] computations for the Bodensee, which has a maximum depth of about 250 meters. His results show (1) that it would take oxygen about forty-two and a third years to pass from the surface to the bottom of this lake by the process of diffusion alone; (2) that it would take over a hundred thousand years for the quantity of oxygen which its waters at a temperature of 10° C. are capable of holding, to diffuse into a body of water of equal area and unlimited depth; (3) that, under natural conditions, with the depth limited to 250 meters, it would require over a million years for this body of water to become saturated at the above temperature if it had no

1 Vol. XXXIV., pp. 239, 562 and 874.

2 *Internat. Revue,* Bd. V., p. 448.

3 *Arch. für Anat. und Physiol.* (Physiol. Abteil.), 1897, p. 112.

dissolved oxygen and acquired a supply only by diffusion from the atmosphere.

If ocean waters were aerated solely by diffusion from the atmosphere we should expect the upper strata to possess a larger amount of dissolved oxygen than the lower. But such is not the case in the tropical Atlantic, for instance. Here the smallest amounts, one to two cubic centimeters per liter of water, are found between the depths of 150 and 800 meters, while the water between 1,100 and 1,500 meters contains twice as much or more, that is, three to four cubic centimeters per liter.[4]

The Black Sea affords an excellent illustration of the inefficiency of diffusion in the process of aeration. Owing to the greater salinity, hence greater density, of the lower water the vertical currents do not penetrate to the bottom of the sea; that is, the lower portion is permanently stagnant and oxygen can pass into it only by diffusion. But Lebedinzeff[5] found no dissolved oxygen below a depth of 200 meters, the aerated portion comprising only about eight per cent. of the maximum depth of this body of water.

Similar conditions are found in many freshwater lakes during the summer period of thermal stratification. At this time the cool lower stratum of water is cut off from contact with the air by the warm upper stratum and can receive new supplies of oxygen only by diffusion from the latter. If the former loses any or all of its dissolved oxygen during the stagnation period, however, the deficiency continues until the autumnal overturning takes place.[6]

In view of these facts it is evident that some agent other than diffusion is responsible for the aeration of bodies of water. In lakes aeration is accomplished by the vernal and autumnal overturning of the water and its subsequent circulation for a longer or shorter period. In speaking of the aeration of ocean waters Helland-Hansen[7] states that "these gases are absorbed at the surface from the atmosphere and are carried by currents even into the deepest parts of the ocean in varying amounts."

C. JUDAY

[4] Schott, "Physische Meereskunde," p. 72.

[5] "Aus der Fischzuchtanstalt Nikolsk," No. 9, p. 113.

[6] Birge and Juday, Bull. XXII., Wis. Geol. and Nat. Hist. Survey.

[7] "The Depths of the Ocean," p. 253.

AN ANOMALOUS EFFECT OF RÖNTGEN RAYS

AN unexpected effect due to X-rays has been brought to my attention, which I believe has been hitherto unobserved. The result is obtained as follows:

Let a sensitive plate be placed film down upon a silver coin, and let a second silver coin be so placed above the plate that areas of contact of the plate and coins partially overlap. Now let the plate and coins which are enclosed in a light-tight box be exposed to X-rays from above.

When the plate is developed, the result is of course a light area with but little effect due to radiation transmitted by the upper coin and a dark area due to the secondary radiation from the coin below. The anomaly appears at the area of overlapping coins. Since this receives its impression both from transmitted rays and from the secondary rays from the coin below, it is to be expected that this area will be darker than the remaining area shaded by the upper coin. The opposite is true, and the area of the overlapping coins is always lighter, *as though the secondary radiation from the lower coin cancelled the effect of the rays transmitted by the upper coin.* When small plates of lead are substituted for the silver coins, the effect is reversed, and the area in question is *darker* instead of lighter. This is the result that one would expect.

The writer has tried many combinations of metals in this manner and has found that the anomalous effect occurs in a number of cases, as for two gold coins, copper coins, gold and silver, and many others.

The question which the case suggests is in regard to the manner in which the neutralization of the effect of the transmitted rays is brought about by the secondary rays and why it seems to be so complete in some cases and not in others. The writer has tried to ascer-